

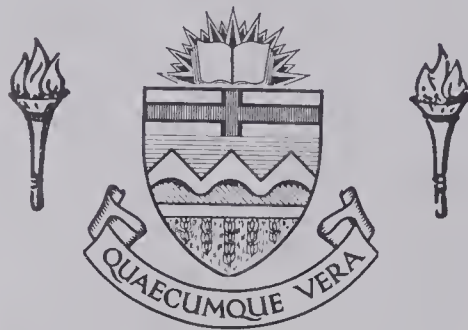
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THE INTERACTION OF COMPETITION AND ABILITY LEVELS
IN THE PERFORMANCE AND LEARNING OF A MOTOR TASK

by

© LEONARD MANLEY WANKEL

A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "The Interaction of Competition and Ability Levels in the Performance and Learning of a Motor Task," submitted by Leonard Manley Wankel in partial fulfilment of the requirements for the degree of Master of Arts.

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ABSTRACT

The purpose of this study was to investigate the interaction of aspects of competition and varying ability levels upon the performance and learning of a motor task. To accomplish this end, four hypotheses were formulated and tested:

1. A competitive situation in the early stages of the learning of a motor skill will retard performance.
2. A competitive situation in the late stages of the learning of a motor skill will facilitate performance.
3. The effects of a competitive situation cease to be detrimental early in the stages of learning a motor task when the initial ability level of the individual is high.
4. The effects of a competitive situation cease to be detrimental late in the stages of learning a motor task when the initial ability level of the individual is low.

Seventy-two grade eight boys were dichotomized into high and low ability groups, on the basis of performance on a five trial pre-test on a stabilometer. The high and low ability groups were then subdivided so as to form thirty-six member control (i.e., non-competitive) and experimental (i.e., competitive) groups for each ability level. Each group performed twenty-five 20-second trials on the stabilometer task under the appropriate test conditions. The twenty-five trial scores were

grouped into five 5-trial performance stages to facilitate analysis of the results.

The high ability groups performed consistently better than the low ability groups. Competition did not influence overall performance; however, it had a detrimental effect upon the low ability group's performance during the second stage and a beneficial effect upon the high ability group's performance during the fourth stage.

Although learning occurred in all groups, the low ability subjects learned at a faster rate than the high ability subjects. Competition had a significant effect on the rate of learning. It retarded learning in the early trials and facilitated it in the late trials. In terms of amount of learning, the low ability groups learned significantly more than the high ability groups and the competitive groups learned more than the non-competitive groups over the twenty-five trials. When learning was divided into early (i.e., first-half) learning and late (last-half) learning, two effects reached significance. The low ability subjects learned more than the high ability subjects during early learning and the low ability-competitive subjects learned more than the low ability-non-competitive subjects during late learning.

No statistically significant support was derived from this study for the first two hypotheses, however, the performance curves did indicate a trend in the hypothesized directions. The final two hypotheses were supported by the results.

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CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

A commonly accepted, but relatively unproven, notion in physical education and athletics is that competition tends to enhance the learning and performance of motor tasks. Although considerable literature exists concerning the beneficial effects of competition over non-competition in various situations (1,10,14,20,43,61,63,65,67, 83,91,95,96,97), the evidence is by no means unanimous. Numerous studies have been reported wherein competition had detrimental effects upon performance (20,63,70,82,91,95).

Evidence has not been brought forward to indicate why competition in some cases benefits performance, while in other instances it deters it. Cratty (18:36), however, has proposed an explanation for the differential results. He says that the effects of competition on performance can be interpreted in terms of the Yerkes-Dodson Law. According to this law, there is a desirable tension level for the performance of any skill. Optimum performance will not be achieved if this level is exceeded or not attained. Furthermore, the law maintains that as tasks increase in complexity, the optimum tension level decreases (Figure 1).

Competition, in this sense, is considered to be a psychological

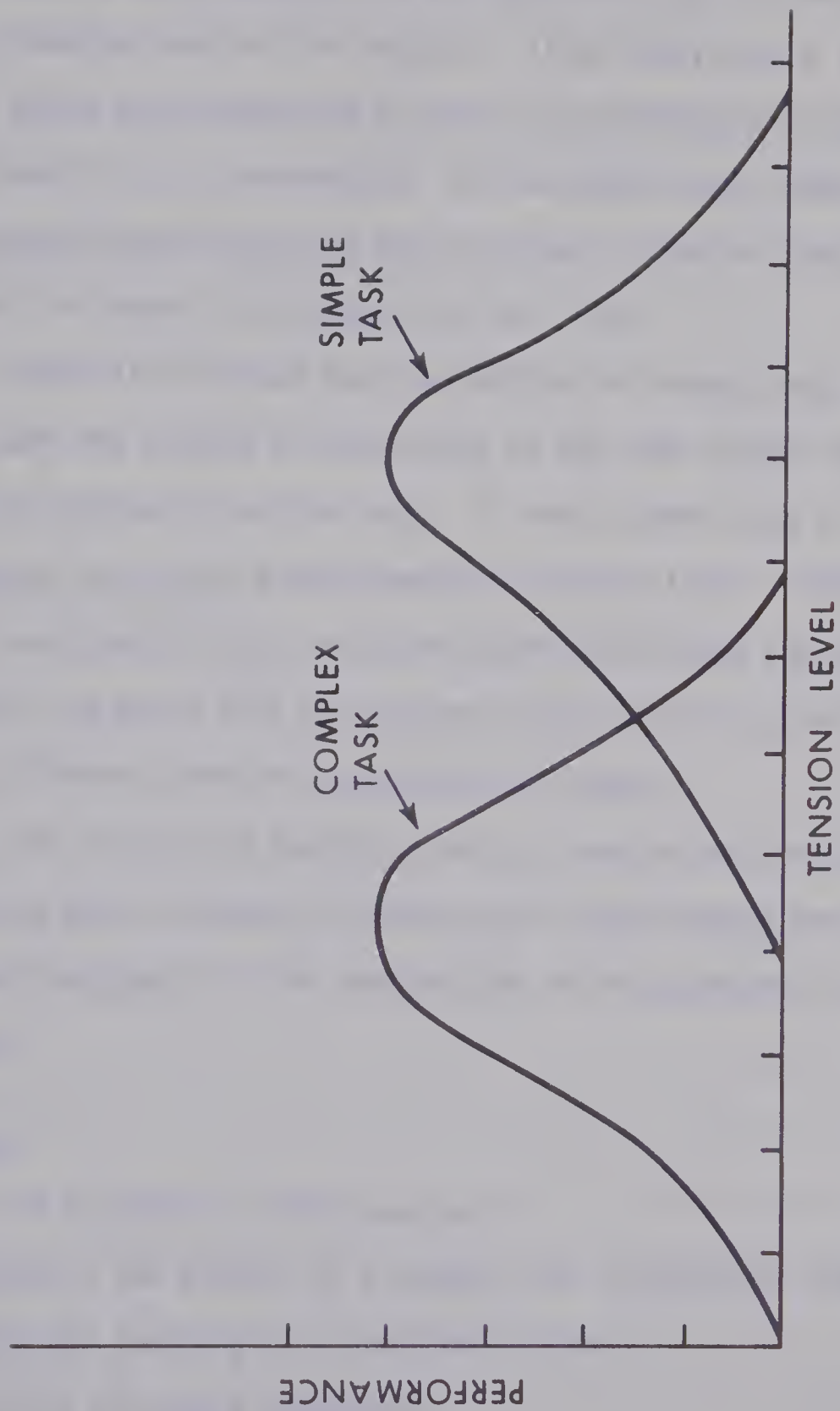


FIGURE 1: THE YERKES - DODSON LAW

stressor which brings about an increase in tension level. Its effects upon performance would depend upon the complexity of the task and upon the prior tension level of the subject. If an individual's tension level was below the optimum for a task, the introduction of competition would be beneficial to performance. On the other hand, competition would exacerbate performance if the individual's tension level was already at, or beyond, the optimum for that task.

Ryan (71,73) found that the effects of stress upon performance depended upon the subject's proficiency in the task as well as upon the level of difficulty of the task. In both studies Ryan utilized shock-induced stress and a stabilometer balancing task. Fleishman (31), Castaneda and Lipsitt (12), Saltz and Riach (69), Deese and Lazarus (22), Elliot (25), and Locke (56) have gained similar results using different tasks and different forms of psychological stress.

The findings of Ryan and Cratty's speculation that competition acts like any other stressor in obeying the Yerkes-Dodson Law, were of fundamental importance in the construction of the hypotheses tested in this study.

The Problem

The purposes of this study are:

- A. To determine the effects of a competitive situation on the performance and learning of a gross motor task.
- B. To test the following hypotheses:

- (1) A competitive situation in the early stages of the learning of a motor skill will retard performance.
 - (2) A competitive situation in the late stages of the learning of a motor skill will facilitate performance.
 - (3) The effects of a competitive situation cease to be detrimental early in the stages of learning a motor task when the initial ability level of the individual is high.
 - (4) The effects of a competitive situation cease to be detrimental late in the stages of learning a motor task when the initial ability level of the individual is low.
- C. To formulate a more precise and comprehensive hypothesis concerning the effects of a competitive situation on motor learning and performance.

Importance of the Study

Little evidence has been published to indicate why competition at times is beneficial to performance while at other times it is detrimental. The interaction of the effects of competition and ability levels upon performance and learning is one area of study which is directly related to this problem. It would seem important, therefore, to investigate whether or not the effects of competition are the same for both high and low ability children. This aspect assumes general importance when it is realized that children with large individual differences are grouped together, in both classroom and gymnasium situations, for the learning of motor tasks. Any information concerning the differential effects of an independent variable, such as competition, should facilitate or clarify our knowledge with respect to motor learning and performance.

Delimitations

1. The sampling of subjects was limited to seventy-two grade eight boys in two different Edmonton junior high schools.
2. The study, by definition, was limited to the effects of individual (pair) competition. It did not include self or group competition.

Limitation

The study was limited by the precision of the two stabilometers.

Definition of Terms

Performance. Performance is the score received on any single trial, or discrete group of trials, by an individual or group of individuals, on the stabilometer.

Learning. Learning is inferred from the improvement in performance over a series of trials as a result of practice. It is operationally defined as the raw gain in performance between the initial level of performance and final level of performance for each individual subject.

Ability Level. Ability level is operationally defined as that level above or below the median of all subjects' scores from a pre-test situation.

Competition. Competition is that situation in which an individual's success is determined by some characteristic of his response in comparison to that of another individual. This situation includes both conditions of social facilitation (the effect from the mere presence

of others making the same movement) and rivalry (the emotional reinforcement of movement accompanied by the consciousness of a desire to win).

Interaction. An interaction effect is an effect attributable to the combination of variables above and beyond that which can be predicted from the variables considered singly. It is important, in that prediction can be made as to what happens when two or more variables are used in combination.

CHAPTER II

REVIEW OF THE LITERATURE

This review of literature covers four main areas. First, studies dealing with the effects of competition, including rivalry and social facilitation, are presented. The second major section deals with the effects of various psychological stressors upon performance. Section three presents those studies in the more limited area of the effects of stress upon performance at different stages of learning a skill and upon individuals of different levels of ability. The final section deals with studies concerning the Yerkes-Dodson Law, that is, the effect of stress upon the performance of tasks of different complexity.

I. THE EFFECTS OF COMPETITION UPON PERFORMANCE

According to Allport (2), competition involves two distinct motivational factors:

In all kinds of competitive performance we may recognize two social factors. The first is social facilitation, which consists of an increase of response merely from the sight or sound of others making the same movement. The second is rivalry, an emotional reinforcement of movement accompanied by the consciousness of a desire to win. Although the effects of the two are difficult to distinguish, they are in reality distinct factors in the total response. (2:262)

This review of the literature, concerning competition, will include studies investigating rivalry and social facilitation as well as those of "competition" itself.

Berridge (10), in a strength study, using 61 college men as subjects, found mean scores were higher for subjects who performed with one another (i.e., social facilitation) and who were told the results of their performance, than for subjects who performed alone and were not given knowledge of results.

Strong (87), investigating the effects of motivation involving five different forms of competition on performance in physical fitness tests, found that team competition was a more effective motivating condition than (a) competition against self, (b) competition to establish class records, (c) competition against someone of nearly equal ability, or (d) competition against someone of markedly different ability. With regard to individual competition, he found that it was effective only for the good performers in the class.

Triplett (91) studied the effect of competition upon the speed of winding fishing reels. Forty children either worked alone or together in pairs. Triplett found that twenty subjects did better with competition, ten were unaffected by it, and ten did less work under competitive conditions.

In a later study, Wilmore (97) investigated the work capacities of twenty-two college males on a bicycle ergometer under competitive and non-competitive conditions. The mean work output and riding time

for the competitive condition was significantly greater than for the control condition.

Moede (63) in a study of the effects of rivalry on hand grip strength, found that performance during dual competition exceeded that of solitary performance. He further found that best strength scores were attained for individuals participating in a form of group competition.

In an accompanying study, reported in the same publication, Moede found that competition had a differential effect upon speed of tapping for subjects of different ability levels. The initially poor individuals improved with competition while the superior subjects did worse. He explained these results by speculating that rivalry tended to stimulate the slower performers, whereas the superior subjects realized the ease of winning, lost interest, and slackened their efforts.

Whittemore (95) studied the effects of rivalry on the performance of a simple task involving the use of rubber types to print paragraphs from the daily press. Twelve college students were instructed to work as fast and as accurately as possible (i.e., quantity and quality). All subjects produced more work when competing than when working alone; however, the least capable in speed profited the most from competition. All subjects did poorer work when competing. The subjects thus emphasized speed over accuracy even though they were told that both were of equal importance.

Abel (1) in a study of the effects of social facilitation

upon pencil maze performance, involving girls of two different sub-normal intelligence levels, reported results contrary to those of Moede (63) and Whittemore (95). She found that although both intelligence groups performed better when working in a social situation, the more intelligent group profited most from social facilitation.

Shaw (82) studied the effectiveness of cooperation and competition in motivating performance on a perceptual tracking task and a memory-reasoning task. On the tracking task, competition was the least effective condition, cooperation was the most effective, and the individual situation fell between the two. On the memory-reasoning task, the competitive condition again produced the poorest performance. There was no significant difference between the performance of the individual and cooperative situations.

Noble, et al (67) studied the effect of social facilitation upon performance of a reaction time task and a rotary pursuit task. All subjects practiced the two skills under social conditions and then half of the subjects were visually isolated for the remaining trials.

The individual group suffered a significant and uniform decrement in performance on the discrimination task but showed no change on the pursuit rotor task. It was suggested that the role of social facilitation in perceptual motor learning depends upon task factors that have not yet been analyzed. Perhaps, in a task such as the pursuit rotor, where constant attention is required, there is no effect due to social facilitation, whereas, in a task such as the re-

action time task, where continuous attention is not required, there is a social facilitation effect.

Church (14) tested 92 subjects on a simple and a discriminative reaction time task under normal and competitive conditions. Both types of reaction time improved under the competitive condition.

Evans (26) investigated reaction time under conditions of non-social competition, social competition, and alone. The non-social competition involved performing a reaction time task while attempting to defeat a mechanical instrument. The social competition condition involved competing with another person. Sixty university students performed the reaction time test for fifty trials under each of the three conditions. There were no significant differences in the reaction times for the different conditions.

In a second study, Evans (27) investigated the effects of competition upon performance in order to determine if competition could be separated into rivalry and social facilitation components. The task involved placing blocks into their proper places on a form board. The subjects, one hundred and twenty male college students, were given five one-minute practice trials and then were given the critical test. Although both rivalry and social facilitation caused significant increases in activation as measured by heart rate, neither factor had a significant effect upon performance nor was there a significant interaction effect.

Evans used the activation scores and Duffy's theory of an

inverted U-relationship between performance and activation, to conclude from his study that rivalry and social facilitation are separate motivational components in competition.

Dashiel (20) studied mental performance when individuals worked: (a) alone, (b) together with a co-working but non-competitive group, (c) when competing with others and (d) under the close observation of spectators. Tests utilized in the study were multiplication, analogies, and word associations. It was found that: (a) spectators facilitated speed at the expense of accuracy, (b) rivalry had no clear effect on performance, and (c) rivalry had a differential effect from the mere presence of others, regardless of whether they were co-workers or spectators.

In another early study, Hurlock (44) found a more definite effect of rivalry upon performance of arithmetic tasks. The rivalry group performed 41 percent better than the control group, with girls gaining slightly more than the boys, and the younger children responding more to rivalry than the older children. As in Moede's (63) study, the subjects of inferior ability benefited more from rivalry than did the superior or average children. Contrary to Whittemore's (95) results, Hurlock found in her study that accuracy improved with the rivalry incentive. This difference is not unexpected as Whittemore's subjects were pressed for time, whereas Hurlock's subjects were not. Hurlock also found that the rivalry group, which was defeated on the first day, never recovered but performed poorly throughout the experiment.

Maller (61) also found that competition facilitated high scores on arithmetic tasks for both boys and girls.

In a slightly different study, Wickens (96) investigated the effects of competition on the performance of arithmetic tasks of various degrees of difficulty. Competition facilitated a greater improvement in the performance of easy problems than in the performance of difficult problems.

In 1932, Forlano (32) performed a study investigating the effects of competition on speed of cancelling out the letter "e" on a typed page. The subjects performed the task under four different conditions: (a) individual competition, (b) working for the class, (c) competition between the teams comprised of both sexes and (d) competition between the sexes. The study was limited by the variability of the prizes offered for the different test conditions. Competition between the sexes was the most effective incentive condition, followed by individual personal gain, team competition and the desire to help the class.

In a similar study, Mukerji (65) found that performance of a cancellation task in a group situation exceeded that in isolation by 20 percent to 27.7 percent.

Summary

The foregoing studies on competition suggest that:

1. Competition can facilitate better performance of simple, forceful acts.

2. Reaction time may or may not improve under competitive conditions.
3. Performance on tracking tasks may be hindered or unaffected by competition.
4. Performance of more complex motor skills may be facilitated, hindered or not affected by the presence of a competitive situation.
5. Competition generally improves performance on pencil and paper (i.e., mental) tests, though in some cases it can have a detrimental effect.
6. In some situations, competition may facilitate speed but deter accuracy of performance.
7. The effect of competition upon performance may be different for high and low ability subjects.

II. THE EFFECTS OF PSYCHOLOGICAL STRESS UPON PSYCHOMOTOR PERFORMANCE

A basic assumption under consideration in the present study is that competition generally acts as a stressor in raising a person's tension level. The following section concerning the effects of different psychological stressors upon psychomotor performance would seem to bear out at least the face validity of this assumption.

The Effects of an Audience Upon Psychomotor Learning and Performance

Gates (33) studied the effects of a small audience and a large audience upon the performance of: (a) the Three Hole Coordination Test, (b) the Woodworth-Wells Analogies Test and (c) the Woodworth-Wells Colour

Naming Test. There were no statistically significant differences between the performances of the control group and the two experimental groups.

Icheiser (46) found 46 percent improvement in putting a block test together when the experimenter was present rather than absent.

Lorenz (57) found that group work, as opposed to working in isolation, increased efficiency up to 40 percent.

Travis (89) found that pursuit rotor performance in a social situation was superior to that when only the experimenter was present. Twenty-two college students performed the pursuit rotor task alone until their learning curves flattened out and their performance showed no improvement for two days. They then performed five trials alone with the experimenter and then ten trials before a passive audience.

Silent observers did not significantly affect the efficiency of learning a finger maze in a study reported by Pessin and Husband (69). Three groups of thirty college students were the subjects for the experiment. A control group learned the maze, while blindfolded, with only the experimenter present. One experimental group learned the maze while blindfolded, with one or two spectators present, while the other experimental group learned the maze with vision allowed, but the maze screened from view. Although social stimuli had no significant effects upon the rate of learning, performance in the presence of spectators

was more variable than isolated performance.

In a relatively recent study, Singer (73) studied the effects of spectators upon the performance of athletes and non-athletes on a gross motor task. Sixteen college athletes and sixteen non-athletes were given ten 30-second practice trials on a stabilometer. The next day they were given three more trials alone, and then three trials in front of a group of spectators. The non-athletes surpassed the performance of the athletes on the ten practice trials and they were significantly better on two of the three trials in front of spectators.

Laird (51) investigated the effects of a passive audience and a "razzing" audience upon performance of: (a) a speed tapping test, (b) a three hole coordination test, (c) a sitting steadiness test, and (d) a standing steadiness test. "Razzing" caused all subjects to perform more poorly on the steadiness tasks. It had a less detrimental effect upon performance of the coordination and tapping tasks. Widespread individual differences were evident in the reactions of the different subjects to "razzing".

Singer (85) concluded, regarding the effects of spectators upon performance:

Generally speaking, excluding such factors as skill complexity, degree of skill attainment, and the person's anxiety level, the presence of others is usually found to have a stimulating effect on performance. When simpler processes and abilities are taxed, social influence will be relatively slight. If the skill, especially if it is difficult, is in the stage of being learned, there are some indications that the presence of others might prove to be detrimental. A skill well learned and demonstrated for

viewers should be executed in a constant and stable manner. Highly developed skills are less prone to distraction. (74:257)

The Effects of Motivational Instructions Upon Performance and Learning

Bell (9) studied the effects of experimentally induced muscular tension and frequency of motivational instructions on pursuit rotor performance. Muscular tension was varied by requiring the subjects to hold different amounts of weight in their non-performing hands. Instructions to improve were given to the subjects at varying frequencies. Neither the frequency of the instructions nor the degree of induced muscular tension had significant effects upon performance.

Noble (66) similarly found that motivating instructions did not affect performance at three stages of learning a continuous tracking task. Four hundred subjects practiced a two-hand coordination test for thirty-two minutes. After each quarter of the practice time a group of one hundred subjects was randomly selected to receive supplementary verbal instructions. Each experimental group was informed of its score and the required score necessary to "pass the test". This required amount was 25 percent above the initial score in all cases.

The experimental groups showed no significant gains over the control group on the post-treatment minus pretreatment scores.

Kushner (50) also found that motivating instructions had no significant effects upon simple reaction time. Motivational instructions were only given during a two minute rest period between the 35th and 36th trials on the 65 trial session. The subjects for the study were

twenty-four hospitalized male patients and twenty-four non-hospitalized males.

Johnson (48) studied the effects of an instructor's verbal encouragement upon the bicycle ergometer performance of pre-pubescent, pubescent, and post-pubescent junior high school boys. The exercise task involved pedalling a bicycle ergometer at maximum effort against a resistance of five pounds for eight 30-second trials. Thirty-second rest periods were interspersed between the exercise bouts. There were no significant differences in work output between the motivated and non-motivated trials. The subjects worked faster initially on the motivated trials, but as they could not keep up the pace, their total work output did not improve. The motivating instructions caused increased tonus of the antagonistic muscles and also hindered cardiovascular recovery after exercise. Johnson noted that the effects of encouragement were not the same for all subjects.

The Effects of Other Forms of Psychological Stress on Motor Performance and Learning

Hurlock (43), Gates and Rissland (34), and Ulrich and Burke (93) found success motivation to be more effective than failure stress in stimulating performance. In all cases, failure stress elicited better performance than the control condition. The tasks utilized in the respective studies were: an arithmetic test, a coordination and a color discrimination test, and a bicycle ergometer task. Contrary results were reported by McClelland and Apicella (58) who found that failure

stress slowed down the rate of learning a card sorting task. In a study of a slightly different nature, Davids and Oliver (21) found that hyper-aggressive subjects learned a finger maze faster than "normal" subjects, with or without failure stress.

The effects of failure stress upon performance have been shown by Bayton and Whyte (6) and Bayton and Conley (7) to depend upon the success background of the subject. Early failure stress may inhibit performance while failure after prolonged success may increase motivation.

Electric shocks, either for right or wrong responses, generally facilitate learning of motor mazes as demonstrated by Muenzinger (64), Crafts and Gilbert (16), Gurnee (38) and Feldman (30). Gilbert (35) concluded, after a series of studies, that electric shock can have both an information giving and a motivating function in maze learning. Shock for errors has also been shown to facilitate learning of a pursuit rotor task by Travis and Anderson (90) and a mirror tracing task by Barlow (5).

Henry (41) found that both reaction time and movement time improved under shock induced stress. In a follow up study, Howell (42) found that tense subjects improved significantly more than non-tense subjects on a reaction time task when shocks were given for slow reactions.

Various stressors have been found to detrimentally affect performance. McKinney (59) found that time stress (i.e., requirement

to finish a task in a given time) increased the number of errors on a finger maze and on a motor steadiness task. In a later study, McKinney, et al (60) found two kinds of reactions to failure-time stress. Most subjects speeded up performance at the expense of accuracy while a few subjects performed steadily without any significant change in performance. Beam (8) investigated the effects of different university stressful conditions upon the rate of serial learning and simple conditioning. Stress interfered with serial learning but facilitated conditioning. Hennis and Ulrich (40) found that stress, introduced by the presence of a note-taking instructor, significantly affected depth perception, steadiness, blood pressure, and simple hand-eye coordination. Except for blood pressure, however, the changes were not directional. Jackson (47) found that fear-induced stress caused aerial gymnasts to perform poorly and to exhibit a lack of coordination.

Summary

On the basis of the foregoing review of the literature, it appears that:

1. An audience may have either beneficial or harmful effects upon performance.
2. The effect which an audience's "razzing" has upon performance depends upon the task and the individual involved.
3. Success is generally a more effective motivator than failure. Failure stress, however, may elicit better performance than a

control condition, wherein neither success or failure reports are given.

4. Performance is not significantly affected by motivating instructions given by an instructor.
5. Electric shock-induced stress may have beneficial, detrimental, or null effects upon performance of different tasks. It may also have differential effects upon individuals within the same task.
6. Generally, simple tasks (i.e., conditioning or reaction time) improve under stress conditions, whereas more complex tasks yield more variable results.

III. THE EFFECTS OF STRESS UPON PERFORMANCE AT DIFFERENT STAGES OF LEARNING A SKILL AND UPON INDIVIDUALS OF DIFFERENT ABILITY LEVELS

In a study involving air force personnel, Fleishman (31) found that supplementary motivation instruction facilitated an improvement in the performance of high ability subjects but not low ability subjects. The task involved was the Complex Coordination Test, which involves joystick and rudder-pedal manipulation.

Locke (56) gained less conclusive results, in a series of four studies, investigating the interaction of ability level and motivation. In a study utilizing the same task as Fleishman (31) had used, motivation was found to have a greater, but not significant, effect on the high ability subjects than on the low ability subjects. The other

three studies all involved a form of test wherein the subjects were required to list names of objects, etc., meeting a certain criterion. The results of these studies varied greatly, with a significant interaction effect occurring in only one study. Motivation level was varied in all four studies by asking the subjects to meet different standards of achievement.

Locke concluded:

In both tables the overall mean t ratios for the motivation and ability effects are greater for the High Ability and High Motivation groups, respectively, than for the Low Ability and Low Motivation groups. However, in both tables there are an ample number of significant motivation and ability effects for Low Ability and Low Motivation subjects. Thus, although there is some indication that the effects of motivation and ability may be relatively greater for High Ability and High Motivation subjects, there is little evidence that these effects are not significant at all for Low Ability and Low Motivation subjects. (56:724)

Saltz and Riach (79) studied the effects of electric shock stress upon stimulus differentiation at different levels of learning. The subjects, eighty university students, learned discrimination tasks involving both overlapping and non-overlapping stimuli. The task required that the subject push either a left or right switch when a series of three lights came on in a circular arrangement of twelve lights. After the tasks were learned to criterion, stress was introduced by an electric shock.

Subjects who were at high levels of performance prior to the introduction of shock showed little decrement in performance, while those at low levels of performance showed a marked performance decrement.

Also, stress caused no differential effects between overlapping (difficult) and non-overlapping (easy discrimination) stimulus conditions for subjects of high performance level. Subjects who had learned the tasks to low criterion showed greater decrement on the overlapping stimuli than on the non-overlapping stimuli under shock stress. Stress did not facilitate an improvement in performance for any group.

Similar results were gained by Castaneda and Palermo (13) using an apparatus similar to that of Saltz and Riach, in conjunction with a form of time stress. Two groups were given twenty-five trials, while two other groups were given fifty trials to learn a discrimination reaction time task. All groups were given fifty re-learning trials in which three of the five stimulus-response (S-R) elements had been changed. One of each pair of training groups re-learned the task under conditions of time stress.

It was found that stress significantly increased the number of errors on the changed S-R pairs. This increase was more pronounced for the group which had received increased training on the original pairs. There was a tendency, although not statistically significant, for stress to decrease the number of errors on the two unchanged S-R pairs.

In another related study, Castaneda and Lipsitt (12) investigated the effects of time pressure upon the learning of a S-R combination pattern. Some of the combinations were in a compatible arrangement, others were not. The effects of stress upon performance were

found to depend upon the relative strength of the response to be learned. Time stress facilitated better performance of S-R combinations in which the initially dominant combinations were correct. Stress initially hindered performance of S-R combinations in which the dominant combinations were incorrect. The magnitude of the deleterious effects of stress on performance of non-dominant S-R combinations depended upon the level of learning of the subject. As training progressed the detrimental effect of stress was diminished until at the end of training the performance of both groups was nearly identical.

Ryan (72) studied the effects of four different incentive conditions upon hand grip strength. He also investigated the interaction effects of the various incentives and ability levels. Eighty male subjects were ranked on the basis of a preliminary grip strength test. Four ability levels were set up with twenty subjects in each. Four matched groups containing 5 superior, 5 good, 5 fair and 5 poor subjects were then established.

Group I was told to do as well as possible; Group II was verbally exhorted to improve; Group III was told the results of previous trials and was allowed to watch the dynamometer dial; Group IV was told to improve or else they would receive an electric shock. No significant performance differences were found for the four motive-incentive conditions, nor were there any significant interaction effects of ability and incentive conditions.

Deese and Lazarus (22) investigated the effects of failure-

stress on rotary pursuit performance. They found that stress introduced early in learning produced a small decrement in performance, while failure stress introduced late in learning produced a small facilitative effect.

Similar results were achieved by Barlow (5) and Bayton and Conley (7) in their studies cited in the previous section.

Ulrich (92) found that inexperienced subjects experienced greater stress when subjected to various basketball situations than did experienced players.

In two related studies, Ryan (71,73) investigated the effects of electric shock induced tension, introduced at different stages of learning, upon performance of tasks of different degrees of difficulty. In one study (73), he examined the effects of stress upon the ability to perform an easy or difficult stabilometer balancing task. Experimental and control groups were established for the easy task, and two control and two experimental groups were established for the difficult task. The easy task experimental group and one difficult task experimental group received shock initially, while the other difficult task experimental group received shock on the third trial. Each group received twelve trials on the stabilometer balancing task.

There were no significant differences in learning or performance of the experimental and control groups on the easy task. The experimental groups, however, exhibited poorer performance than the controls on the difficult task. The rate of learning, as opposed to

performance level, was independent of the tension level for both the easy and difficult tasks.

In a follow-up study (71) Ryan studied the effects of shock stress upon performance of the stabilometer balancing task after extensive practice. Control and experimental groups were given four practice sessions of twelve trials each on the stabilometer. On the fifth, 12-trial session, the experimental group received a series of electric shocks. In this case, shock introduced late in learning had no significant effect upon performance.

Carron (11) investigated the effects of an early or late shock stressor, upon the ability of high and low anxious subjects to balance on a stabilometer. One hundred and twenty university students, who had been dichotomized on the basis of high or low scores on the Taylor Manifest Anxiety Scale, were given seventy trials on the stabilometer.

The "shock early" group received shocks on trials four to six, while the "shock late" group received shocks on trials sixty-five to sixty-seven. The shock stressor had no effect upon the amount learned in the study. An early shock significantly impaired the performance of the high anxiety groups, while the low anxiety groups were unaffected. A late shock had no significant effect on either the high or low anxiety subjects.

Summary

The findings outlined in the above section would appear to indicate that:

1. Motivating instructions may facilitate improved performance of a complex motor task by high ability subjects but may have no significant effect upon the performance of low ability subjects.
2. Electric shock-induced stress tends to disrupt performance of complex tasks but may facilitate performance of simple well learned tasks.
3. Failure stress may have a slight detrimental effect early in motor learning but it may have a slight facilitating effect on motor performance late in learning.

IV. THE YERKES-DODSON LAW

The Effects of Stress Upon Performance of Tasks of Different Degrees of Complexity

Yerkes and Dodson (98) originally outlined the relationship between stress and task difficulty, pertaining to performance, in 1908. They observed the reactions of dancing mice in distinguishing lights of varying brightness while under different degrees of shock-induced stress. They found that there was an optimum stimulus strength (i.e., shock intensity) for the mice to learn to discriminate between different light intensities. Furthermore, they found that as the difficulty of discrimination was increased, the stimulus which was most favorable to

habit formation approached nearer to the threshold.

Several subsequent studies, using varying tasks and stressors, have shown this principle to hold true for human subjects. The studies by Saltz and Riach (79), Castaneda and Palermo (13), Castaneda and Lipsitt (12), Ryan (73) and Carron (11), cited in the previous section, all provide evidence that the optimum tension level for a complex task is less than that for a simpler task.

Teese and Testa (88) also provide evidence supporting the Yerkes-Dodson Law. They had twenty-four college students perform three card sorting tasks under shock and no-shock conditions. In the first task, the subjects were required to sort forty cards into two piles on the basis of form. In the second task, form and color were used to divide the cards into four piles, while in the third task, the cards were divided into eight bins on the basis of form, color, and presence of a circumflex mark. Each subject received three practice trials and an experimental trial. Shock was given five seconds after an experimental trial began. The difference between the score on the experimental trial and the best practice trial was used in the analysis.

It was found that shock impaired the difficult task, facilitated the medium difficulty task and facilitated (non-significantly) the easy task. The authors interpreted their results in terms of the Yerkes-Dodson Law.

Lazarus and Ericksen (53) investigated the effects of failure threat upon performance of college students on an extended version of

the Wechsler-Bellevue digit symbol subtest. The experimental group was comprised of one hundred and fifteen female college students. Seventy-three mixed college students made up the control group.

It was found that more errors were made under stress, although the loss was compensated for, to some extent, by an increase in speed. Students with high grade point averages (highest quartile) tended to improve their performance under stress. Students with poor academic standing (lowest quartile) did worse and were much more variable, when performing under stress.

Elliot (25) examined the effects of three probabilities of success and three magnitudes of incentive upon reaction time and heart rate. The three probabilities of success were 10, 50 and 90 percent; while the three incentive conditions were payments of one, two or four cents for reaction times faster than the given criterion. Three subjects repeated each matrix of conditions ten times.

The results depended upon the subject's experience. There was a significant motivation effect upon heart rate in the early stages but not later. Speed of reaction time was significantly affected during the later days, but not in the early stages.

The probability of success and magnitude of incentive had an interaction effect upon reaction time.

Related Theories Pertaining to Drive and Performance

Results from studies in the area of "activation" or "arousal" have much in common with the original findings of Yerkes and Dodson.

Duffy (1957), Schlosberg (1954), Hebb (1955), Malmö (1957) and Lindsley (1957) have been the main contributors in the development of a theory of an inverted U-shaped relationship between activation and performance.

Cofer and Appley say:

Activation theorists such as Duffy, Schlosberg, and Malmö have mainly stressed that behavioural arousal can be indicated by a variety of measures and that arousal is a continuum, varying from sleep to excited states. They also urge that behavioural efficiency is a curvilinear function of arousal, being at its peak when arousal has reached intermediate magnitudes. Much evidence in the literature, recent as well as past, supports these general contentions. Lindsley and, to a large extent, Hebb have stressed the role of cortical arousal by means of the nonspecific projection system, a system whose complex neuro-physiological story is beginning to emerge from the laboratory. The implication is that stimulation (which affects arousal) is essential for efficient performance, and probably, that moderate levels of stimulation are preferred by organisms to either very much or very little stimulation. Drive, as Hebb and Malmö would see it, is identical with arousal: it is still an unanswered question how different drives contribute to arousal and, further, just how their qualitative features contribute to the control of behaviour from the activation viewpoint. (15:409-410)

Another approach to the problem of the relationship between drive and performance has been outlined by Spence (86). Spence postulates that in complex learning tasks there are a "hierarchy of competing response tendencies." He says that if, in the beginning stages of learning, the correct to-be-learned response is stronger than the incorrect response, then..."the higher the drive level, D , the greater will the difference between the competing excitatory po-

tentials be and neglecting all other considerations, the higher should the learning criterion be attained, and the smaller should be the total number of errors." (86:189)

On the other hand, Spence says, if at the outset the correct response is weaker than the incorrect one, an increase in drive strength will cause an increase in the percentage of errors during the initial stages of learning. As training proceeds, however, the habit strength of the correct reinforced response will surpass that of the incorrect response and, from that point on, the percentage of correct responses of the high drive group should exceed that of the low drive group.

Summary

1. There is an optimum tension level for the performance of any task. If this optimum level is not reached, or is exceeded, maximum performance will not be achieved.
2. The optimum tension level for performance of a task decreases as the complexity of the task increases.
3. The optimum tension level for a task increases as the task becomes more highly learned.

CHAPTER III

METHODS AND PROCEDURE

The Subjects

The seventy-two subjects used in this study were male grade eight students from two junior high schools in Edmonton, Alberta. Their ages ranged from thirteen to fifteen years, the mean age being 13.9 years.

Junior high school students were utilized as subjects in the study for two main reasons. Firstly, competition is advocated as an effective teaching device for this age group (49). Secondly, it was felt that older subjects might perceive the purpose of the study and thus bias the results, whereas junior high school students might tend to accept the information given to them at "face value".

Only boys were utilized in the study, as different studies (44,63,87) have shown that boys and girls react differently to competition.

McKernan and Allendale Junior High Schools were the schools involved in the study as they were made available for testing by the Edmonton Public School Board.

The Task

Stabilometer balancing was selected as the task for the study,

as it is a well documented motor learning task (3,4,71,73,74,75,76,77,78).

Experimental Design

The experimental design was a randomized blocks design, with two independent variables, competition and ability level (24:233). The two dependent variables were performance and learning.

Four independent groups of eighteen subjects each were established. Each group was tested on twenty-five trials under one of four treatment conditions. The twenty-five trial scores were then sub-divided into five 5-trial performance stages. Table 1 presents a diagrammatical description of the design.

TABLE 1
EXPERIMENTAL DESIGN*

		Trials				
		C ₁ (1-5)	C ₂ (6-10)	C ₃ (11-15)	C ₄ (16-20)	C ₅ (21-25)
High	Ability: A ₁	B ₁	(Competition)			
		B ₂	(Non-competition)			
Low	Ability: A ₂	B ₁	(Competition)			
		B ₂	(Non-competition)			

*Means for Ability (A), Competition (B), Stages (C). Each Cell Entry is the Mean of the Scores of 18 Subjects for 5 Trials.

Apparatus

The apparatus used in the study consisted of a Hanhart Amigo Stopwatch and two stabilometers (Figure 2).

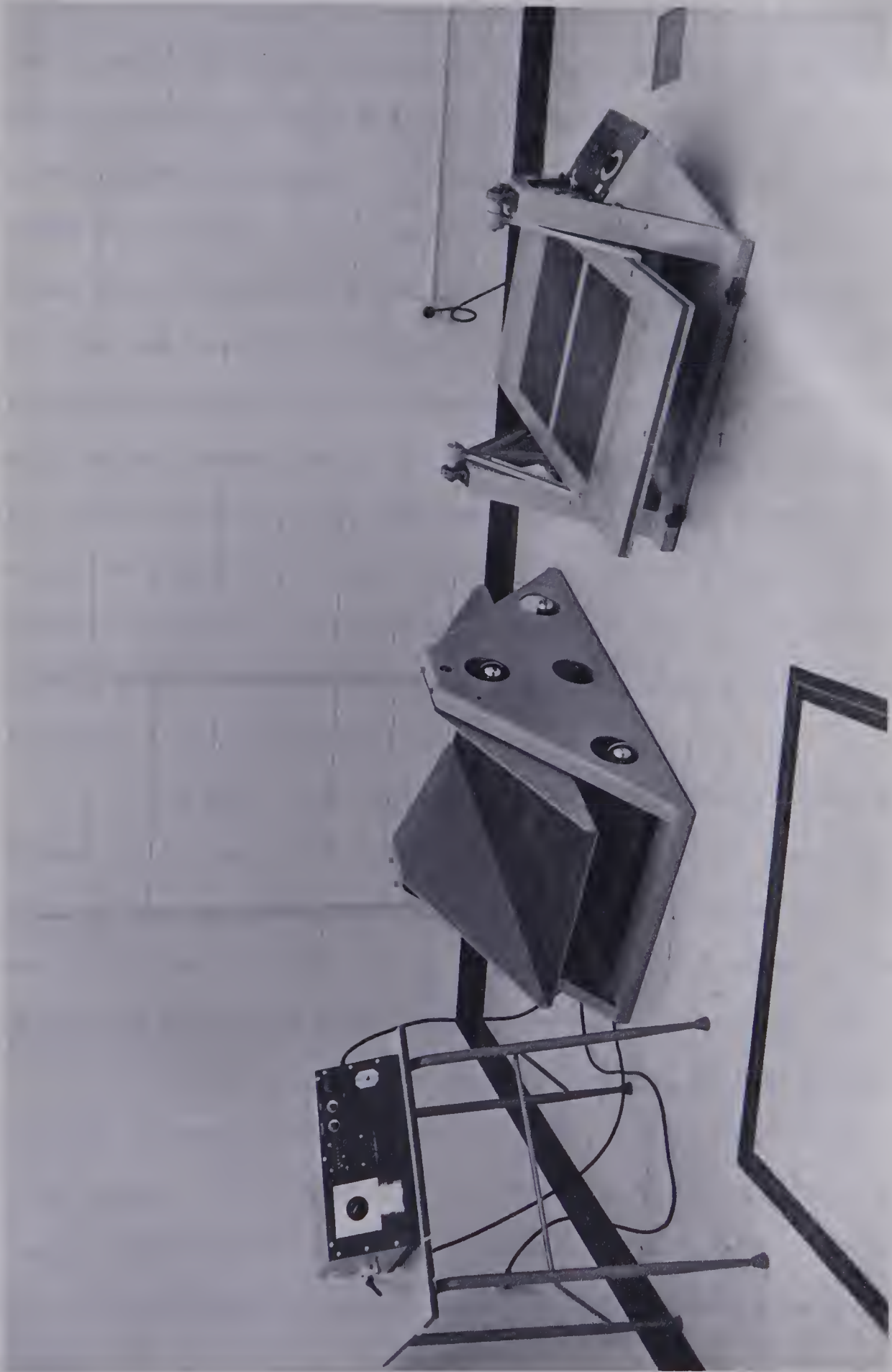


FIGURE 2 The Stabilometers

One stabilometer consisted of a horizontally pivoted one inch plywood platform forty-eight inches by twenty-four inches. Rotation of the platform was provided for by pillar blocks in the steel supporting uprights. The center of rotation was ten inches above the platform. The range of motion of the platform was plus or minus twenty degrees from the horizontal. Motion of the board over this arc was measured in electrical "movement units". This electrical recording was provided by a segment of forty circular contact points with carbon brushes, which provided electrical impulses with the back and forth movement of the platform over the contact segment (the 40° arc). An electrical counter recorded the electrical impulses in degrees of movement. A low score, in movement units, therefore, represents a good performance on the stabilometer task, while a high score indicates a poor performance.

The other stabilometer was of similar design except that it was constructed entirely of steel. The electrical recording mechanisms of the two stabilometers were calibrated differently. A conversion factor ($\times 3.2564$) had to be used in order to make the measurements from the second stabilometer comparable to those of the first.

Both stabilometers included electrical timing devices which were set at twenty seconds to control the length of each trial on the stabilometer. The timing and recording mechanisms were reset at the "start" positions prior to the beginning of each trial. The system was activated when the subject made his first movement to balance the board.

Testing Procedure

The two stabilometers were set up in a testing room at the junior high schools. All subjects were individually admitted to the room and administered five trials on the stabilometer. The subjects were randomly assigned to one of the two stabilometers. Each trial was of twenty-second duration and was followed by a twenty-second rest period. Only the subject and the test administrator were allowed in the testing room at the time of testing. Upon entering the test room the subjects were given the following instructions.

The objective of this task is to balance on the platform (and to keep it) as horizontal, or level, as possible. It is important that you understand this - you must try to keep the platform level with as little movement as possible. Place your feet on the chalk marks, stand up straight, and put your hands on your hips. Maintain this position while balancing. On the command "GO" - begin. On the command "STOP" - stop and rest but do not step off the platform. On the "READY" signal, place your hands on your hips and get ready for the next trial. Do as well as you can on each trial. Any questions?

The test administrator demonstrated the task to each subject as he gave the instructions.

After completion of the pre-testing, the mean scores on the five trials were calculated for each subject. The subjects were dichotomized into high and low ability groups on the basis of the mean scores. The subjects in the high ability group were then randomly divided into two groups and the same was done for the low ability students. One group of each ability level was randomly selected to be the control group (Figure 3), the other was assigned to be the

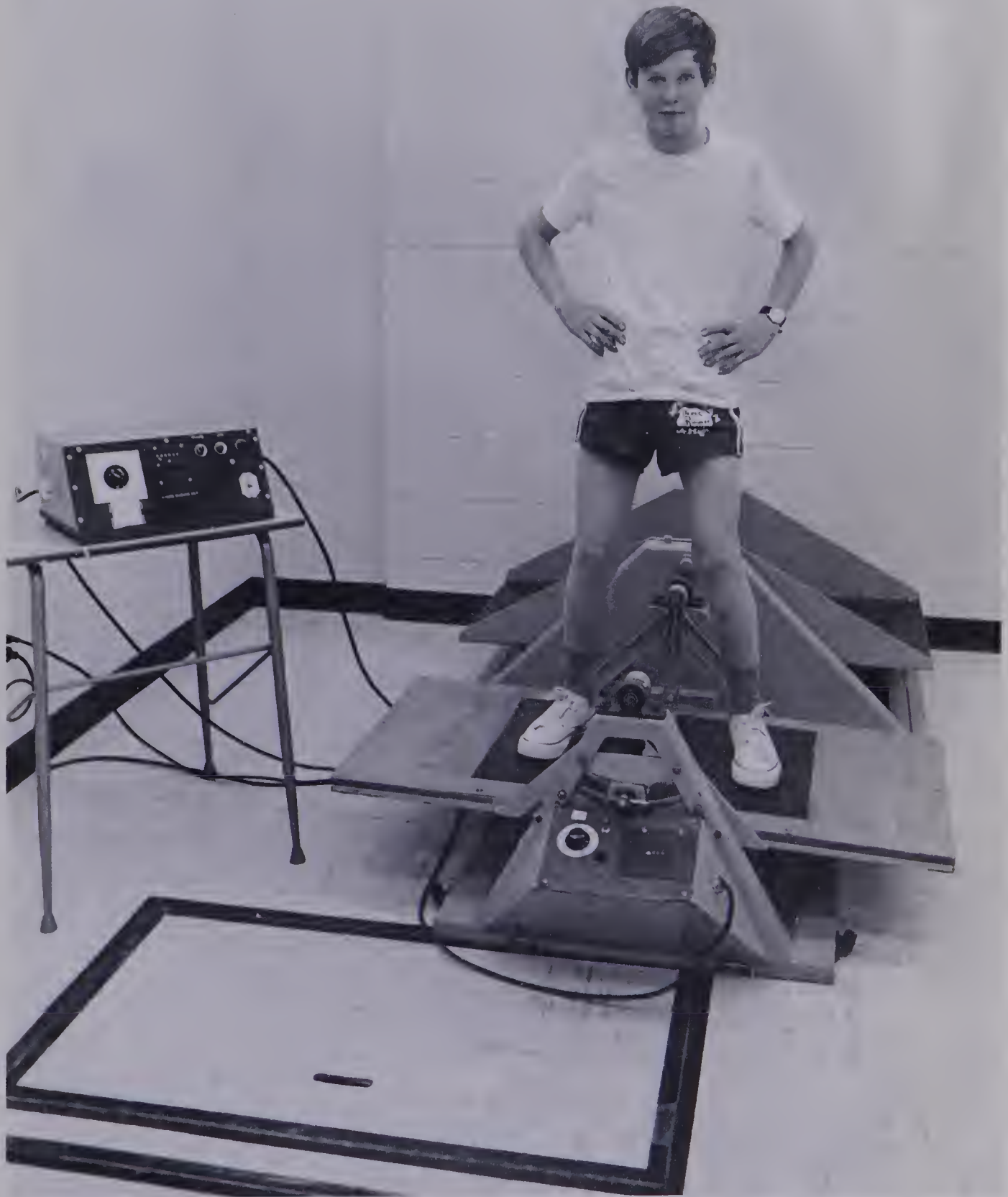


FIGURE 3 Subject Balancing on a Stabilometer Under Control
(i.e., non-competitive) Conditions



FIGURE 4 Subjects Balancing on the Stabilometers Under Experimental (i.e., competitive) Conditions

experimental group (Figure 4). Approximately one week after the pre-test sessions, the subjects returned to the testing room to perform the stabilometer balancing task under test conditions. The two control groups performed the task again exactly as in the pre-test condition. This time, however, they performed twenty-five trials on the stabilometer. Each student was given the same instructions as in the pre-test.

The experimental groups were sub-divided into eighteen pairs of approximately equal ability. One pair of subjects at a time were admitted to the testing room. They were given the instructions as in the pre-test; however, the following instructions were added by the instructor.

You two fellows were just about the same on your first test on the stabilometer. Today I want to find out which of you is the best, so today it is a contest between you. Try to beat your opponent on each trial. All right, let us see who will be the "champ".
(Repeat the operating instructions if necessary).

After every five trials, the subjects were urged to do their best in order to win the competition.

The results were collected and tabulated and then statistically analyzed.

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

The four control and experimental groups in this study were designated as follows: high ability - competitive (HAC); high ability - non-competitive (HANC); low ability - competitive (LAC); and low ability - non-competitive (LANC).

The data collected included the scores for each subject on five pre-test trials and on the twenty-five test trials. The twenty-five test trials were sub-divided into five stages: Stage I (trials 1 - 5), Stage II (trials 6-10); Stage III (trials 11-15); Stage IV (trials 16-20); and Stage V (trials 21-25). The performance score for any one stage, therefore, represents the average of five actual test trials. A learning score represents the difference between two given performance scores.

The analysis of the data consisted of the following procedures. First, the pre-test scores were tested to determine if the random assignment to groups had been effective (i.e., to see if (a) the LAC and LANC and (b) the HAC and HANC groups were significantly different). This was accomplished by performing a one-way analysis of variance (24:120) together with Duncan's New Multiple Range Test (24:136) on the pre-test mean scores and an F-test (24:105) on the pre-test variances. These

results did not reveal any significant differences within each of the two major ability group categories and thus supported the assignment technique. The means of the two high ability groups were significantly different from those of the two low ability groups.

The means and standard deviations for each of the five test performance stages were calculated and tabulated. Two-way analyses of variance (24:177) were performed for each stage to determine if the competition and ability level main effects, the competition x ability level interaction, and the competition within high ability level and competition within low ability effects were significant. Graphic representations of the performance curves for the various test conditions were presented.

The means and standard deviations were calculated and tabulated for the following learning scores: (a) early learning, i.e., Stage I minus Stage III; (b) late learning, i.e., Stage III minus Stage V; (c) total learning, i.e., Stage I minus Stage V.

Finally, a trend analysis (24:233) was performed to analyze the overall main effects due to competition, ability level, and stages and the overall competition x ability level, competition x stages, ability level x stages, and competition x ability level x stages interactions.

I. RESULTS

Pre-test Scores

The means and standard deviations for the pre-test scores for each group are shown in Table II.

TABLE II
MEANS AND STANDARD DEVIATIONS OF THE PRE-TEST
SCORES OF THE FOUR ASSIGNED GROUPS

<u>Group</u>	<u>Mean</u>	<u>Standard Deviation</u>
HAC	259.3	44.06
HANC	268.17	37.30
LAC	409.50	60.76
LANC	398.56	42.91

The pre-test means were subjected to an analysis of variance (Table III) and to Duncan's New Multiple Range Test (Table IV). According to these treatments, the HAC and HANC pre-test means were not significantly different nor were the LAC and LANC pre-test means.

TABLE III
SUMMARY OF THE ANALYSIS OF VARIANCE OF THE PRE-TEST MEANS

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between Groups	355981.67	3	118660.56	50.55**
Within Groups	159611.44	68	2347.23	
Total	515593.11	71		

**p < .01

TABLE IV
DUNCAN'S NEW MULTIPLE RANGE TEST APPLIED TO THE
DIFFERENCE BETWEEN THE PRE-TEST MEAN SCORES

Means	HAC	HANC	LANC	LAC	Shortest Sign. Range
	259.33	268.17	398.56	409.50	@ = .05
259.33		8.84	139.23*	150.17*	$R_2 = 32.3$
268.17			130.23*	141.33*	$R_3 = 33.98$
398.56				10.94	$R_4 = 35.09$
409.50					

*P < .05

Performance Scores

The performance means and standard deviations for each of the treatment groups at the five stages of performance are presented in Table V.

TABLE V
MEANS AND STANDARD DEVIATIONS FOR THE FIVE
DIFFERENT PERFORMANCE SCORE STAGES

Group	First		Second		Third		Fourth		Fifth	
	\bar{X}	S.D.	\bar{X}	S.D.	\bar{X}	S.D.	\bar{X}	S.D.	\bar{X}	S.D.
HAC	185.5	46.0	147.3	31.9	137.4	37.1	125.4	34.9	122.2	32.6
HANC	197.6	46.9	166.2	41.5	158.9	39.7	154.9	38.3	146.1	34.5
LAC	299.0	63.4	251.4	50.4	223.0	45.6	196.8	35.9	188.6	41.8
LANC	264.2	57.5	213.6	48.0	195.5	39.8	184.4	40.6	178.6	38.2

Analyses of variance summaries of the performance scores for the five stages are presented in Tables V through X. Additional graphic representation of the performance scores can be seen in the performance curves presented in Figures 5, 6, and 7. Figure 5 presents the performance curves for the competitive and non-competitive conditions. Figure 6 depicts the high ability and low ability performance curves and Figure 7 presents the performance curves for the four treatment groups (i.e., HAC, HANC, LAC, LANC).

In all five stages of the test trials, ability level had a significant ($P < .01$) effect upon performance. The high ability subjects out-performed the low ability subjects in all cases. With regard to the other effects (i.e., competition, and the interaction of competition and ability level), a variable pattern is observed. In the first and final stages, there were no significant F-scores, while in the middle three stages various scores reached significance at the .05 level. In the second stage, a significant interaction of ability level and competition occurred, indicating that competition had a different effect upon high and low ability subjects (Table VII). Competition facilitated better performance of the high ability subjects but hindered the performance of the low ability subjects (Figure 7). Competition had a significant detrimental effect upon performance within the low ability group. In the third stage, competition again facilitated better performance of the HAC group, but hindered the LAC group as evidenced by the curves in Figure 7 and the significant interaction of

ability level and competition in Table VIII. The ability level x competition effect was again significant in the fourth stage (Table IX); in addition competition significantly improved the performance of the high ability group (i.e., the HAC group performed significantly better than the HANC group). The competition main effect did not approach significance in any of the five stages. This indicates that when the ability groups were considered together competition had no significant effect upon performance (Figure 5).

TABLE VI

VARIANCE ANALYSIS SUMMARY OF FIRST STAGE PERFORMANCE SCORES

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Competition	2337.00	1	2337.00	.758
Ability Level	145890.01	1	145890.01	47.34**
(Competition within HA)	1312.86	(1)	1312.86	.43
(Competition within LA)	10941.16	(1)	10941.16	3.55
Interaction	9917.04	1	9917.04	3.22
Error	209546.69	68	3081.57	
Total	367690.72	71		

**P < .01

TABLE VII

VARIANCE ANALYSIS SUMMARY OF SECOND STAGE PERFORMANCE SCORES

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Competition	1607.45	1	1607.45	.8
Ability Level	103315.43	1	103315.43	51.44**
(Competition within HA)	3207.33	(1)	3207.33	1.60
(Competition within LA)	12844.45	(1)	12844.45	6.40*
Interaction	14444.33	1	14444.33	7.19**
Error	136584.27	68	2008.59	
Total	255951.48	71		

**P < .01

*P < .05

TABLE VIII

VARIANCE ANALYSIS SUMMARY OF THIRD STAGE PERFORMANCE SCORES

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Competition	88.73	1	88.73	.05
Ability Level	67173.34	1	67173.34	38.31**
(Competition within HA)	4160.25	(1)	4160.25	2.37
(Competition within LA)	6784.27	(1)	6784.27	3.87
Interaction	10784.91	1	10784.91	6.15*
Error	119226.14	68	1753.33	
Total	197344.00	71		

**P < .01

*P < .05

TABLE IX

VARIANCE ANALYSIS SUMMARY OF FOURTH STAGE PERFORMANCE SCORES

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Competition	1322.69	1	1322.69	.89
Ability Level	45894.40	1	45894.40	30.83**
(Competition within HA)	7826.35	(1)	7826.35	5.26*
(Competition within LA)	1371.47	(1)	1371.47	.92
Interaction	7875.13	1	7875.13	5.29*
Error	101232.63	68	1488.71	
Total	156324.85	71		

**P < .01

*P < .05

TABLE X

VARIANCE ANALYSIS SUMMARY OF FINAL STAGE PERFORMANCE SCORES

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Competition	879.20	1	879.20	.61
Ability Level	44084.70	1	44084.70	39.48**
(Competition within HA)	5145.67	(1)	5145.67	3.56
(Competition within LA)	888.04	(1)	888.04	.61
Interaction	5154.51	1	5154.51	3.56
Error	98348.63	68	1446.30	
Total	148467.04	71		

**p < .01

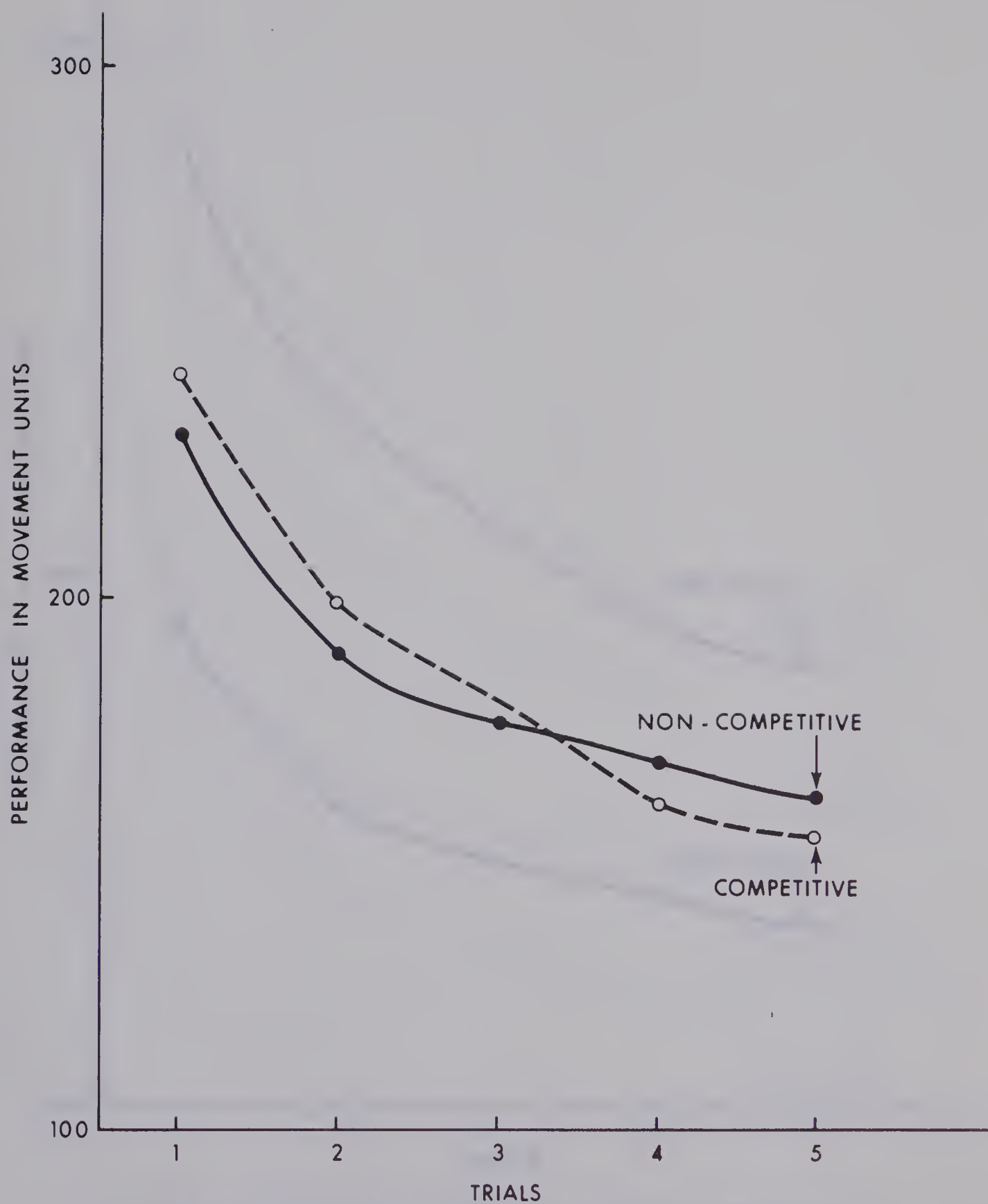


FIGURE 5: PERFORMANCE CURVES FOR COMPETITIVE AND NON-COMPETITIVE CONDITIONS.

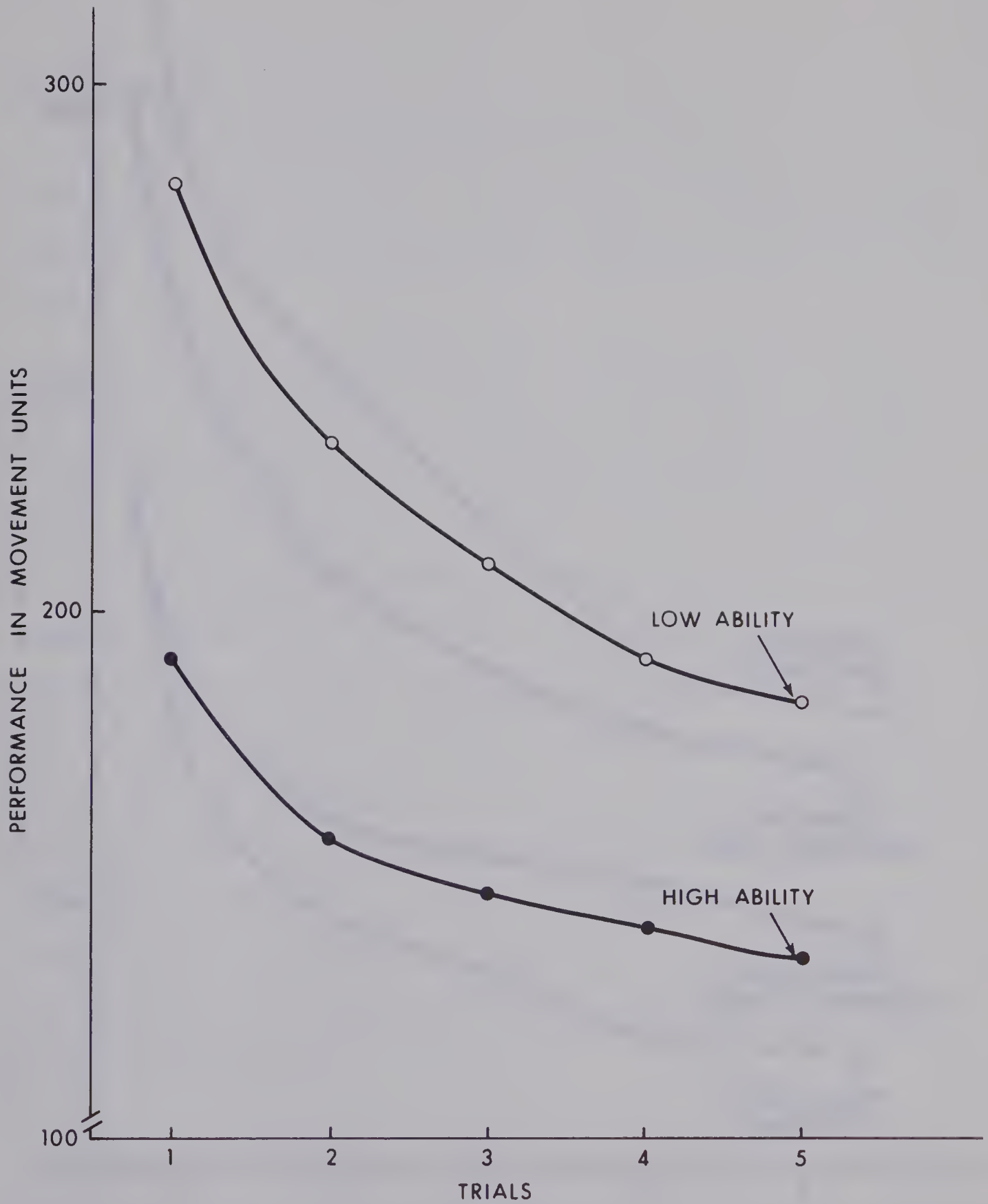


FIGURE 6: PERFORMANCE CURVES FOR HIGH ABILITY AND LOW ABILITY SUBJECTS.

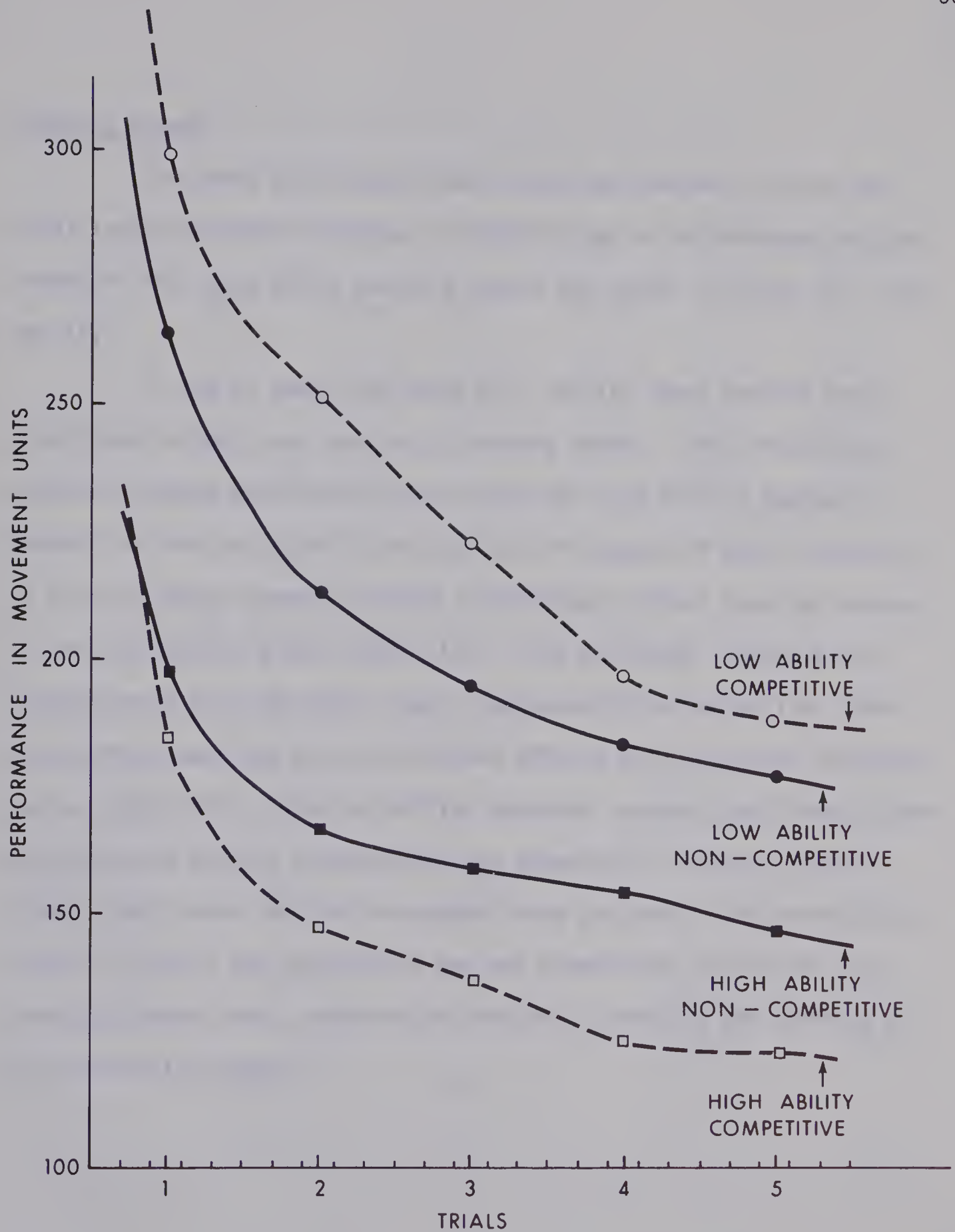


FIGURE 7: PERFORMANCE CURVES FOR THE HAC, HANC, LAC, AND LANC GROUPS.

Learning Scores

The means and standard deviations for the early, late, and total learning scores are shown in Table XI while the variance analysis summaries for these three learning scores are shown in Tables XII, XIII, and XIV.

As can be seen from Table XII, ability level had the only significant effect upon the early learning scores. The low ability subjects learned significantly more than the high ability subjects. Competition did not significantly effect the amount of early learning. In late learning, competition had a significant effect upon the scores of the low ability group (Table XIII). The LAC group learned significantly more than the LANC group. The competition and ability level main effects were the only significant effects upon the total learning scores (Table XIV). The low ability subjects learned significantly more than the high ability subjects and the competitive subjects learned significantly more than the non-competitive subjects. The interaction of ability level and competition was not significant for any of the learning scores, thus, competition similarly affected the learning of the two ability groups.

TABLE XI
MEANS AND STANDARD DEVIATIONS OF THE THREE
LEARNING SCORES FOR EACH TREATMENT GROUP

Group	Early Learning \bar{X}	S.D.	Late Learning \bar{X}	S.D.	Total Learning \bar{X}	S.D.
HAC	48.12	31.27	15.2	15.85	63.4	29.53
HANC	38.7	27.26	12.8	18.60	51.50	30.20
LAC	76.1	33.77	34.4	26.95	110.4	40.28
LANC	68.6	29.97	16.9	31.37	85.5	46.28

TABLE XII
VARIANCE ANALYSIS SUMMARY OF THE EARLY LEARNING SCORES

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Competition	1275.13	1	1275.13	1.283
Ability Level	15074.27	1	15074.27	15.15**
(Competition within HA)	799.01	(1)	799.01	.803
(Competition within LA)	494.32	(1)	494.32	.497
Interaction	18.20	1	18.20	.018
Error	67660.78	68	995.01	
Total	84028.37	71		

**p < .01

TABLE XIII

VARIANCE ANALYSIS SUMMARY OF THE LATE LEARNING SCORES

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Competition	1788.02	1	1788.02	2.927
Ability Level	2422.08	1	2422.08	3.965
(Competition within HA)	52.32	(1)	52.32	.086
(Competition within LA)	2763.25	(1)	2763.25	4.524*
Interaction	1027.56	1	1027.56	1.682
Error	41534.609	68	610.56	
Total	46772.26	71		

*P < .05

TABLE XIV

VARIANCE ANALYSIS SUMMARY OF THE TOTAL LEARNING SCORES

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Competition	6083.04	1	6083.04	4.142*
Ability Level	29581.23	1	29581.23	20.140**
(Competition within HA)	1260.25	(1)	1260.25	.858
(Competition within LA)	5595.04	(1)	5595.04	3.809
Interaction	772.25	1	772.25	.526
Error	99876.757	68	1468.776	
Total	136313.275	71		

**p < .01

*P < .05

Trend Analysis

A summary of the analysis of variance of the overall effects (i.e., stages 1 through 5) due to competition, ability level, and stages is presented in Table XV. The ability level and stages main effects, and the ability level x stages, ability level x competition and competition x stages interactions were all significant. The competition main effect and the ability level x competition x stages interaction effects did not reach significance. From these results it can be seen that: the high ability subjects performed better than the low ability subjects; the subjects, as a whole, improved their performance throughout the stages; the difference between the performance of the two ability groups varied from stage to stage; competition had different effects upon the performance of the two ability groups; competition affected performance differently at different stages (i.e., it affected the rate of learning): competition did not have a significant effect upon the overall performance of the total group; and, competition did not affect the performance of the two ability levels differently at different stages.

The overall means for the four twenty-five trial, performance treatment groups are presented in Table XVI.

TABLE XV
TREND ANALYSIS OF THE EFFECTS OF COMPETITION,
ABILITY LEVEL AND STAGES UPON PERFORMANCE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Ability Level (A)	384617.47	1	384617.47	47.68*
Competition (B)	245.69	1	245.69	.03
(AXB) Interaction	46881.41	1	46881.41	5.81*
Error A (Within Subjects)	548576.09	68	8067.30	
Stages (C)	276750.57	4	69187.64	161.73**
(AXC) Interaction	21740.42	4	5435.10	12.71**
(BXC) Interaction	6060.27	4	1515.07	3.54**
(AXBXC) Interaction	1294.48	4	323.62	.76
Error B (within trials)	116362.26	272	427.80	
Total	1402528.65	359		

**P < .01

*P < .05

TABLE XVI
OVERALL PERFORMANCE MEANS OF THE

FOUR TREATMENT GROUPS

<u>Group</u>	<u>Mean</u>
HAC	143.6
HANC	164.7
LAC	231.8
LANC	207.3

II. DISCUSSION

The Effects of Competition Upon Performance

The failure of competition to have a significant effect upon performance concurs with the results of many other studies (20,26,27, 63,87,91,95). This finding is also consistent with the application of the Yerkes-Dodson Law to competition as proposed in this study. According to this speculation, competition would have a beneficial effect upon performance in some cases while in others it would have a detrimental effect. These variations, in effect, would tend to counter-act each other so that the resultant effect could, logically, be not significant.

The hypothesis that competition would have a detrimental effect upon performance in the early stages and a beneficial effect in the late stages was confirmed by a significant interaction (Table XV) between competition and stages caused by the crossing over of the performance curves of the competitive and non-competitive groups (Figure 5). Though the non-competitive subjects performed better in the early stages and the competitive subjects performed better in the late stages, a separate analysis of the five stages showed non-significant main effects for competition. These differential effects of competition in early and late stages agree with the results of the Deese and Lazarus (22) study of the effects of failure-stress upon pursuit rotor performance. Several other studies, Carron (11), Castaneda and Lipsitt (12), Castaneda and Palermo (13), Ryan (71) and Saltz and Riach (79) have found stress to have a detrimental effect upon performance early in the learning, but to have no significant effect

later in learning.

The Effects of Ability Level Upon Performance

The high ability group (i.e., HAC plus HANC) performed significantly better than the low ability group (i.e., LAC plus LANC), during each of the five performance stages and on the overall twenty-five trials. This would be expected if the pre-test was effective in distinguishing between subjects of high and low ability.

The Interaction of Ability Level and Competition

The interaction effect on performance of ability level and competition over the total twenty-five trials was significant, indicating that competition had different effects upon the high and low ability groups (Table XV). This is similar to the results reported by Fleishman (31) in his study investigating the interaction of motivation and ability level. Locke (56) reported supporting but less conclusive results from four studies of motivation and ability levels. One probable explanation for the less definitive interactions in Locke's studies is that he used a comparatively weak motivating condition. Ryan (72) found that ability level and incentive conditions did not have an interaction effect on the performance of a hand grip strength test. In his study, the four incentive conditions did not have a significant effect upon performance for any ability level. Ryan explained his null results by saying, "It seems probable that the nature of simple tests of physical performance provide sufficient incentives

to elicit maximal performance without additional motivation" (72:87).

In terms of the five performance stages, the competition x ability level interaction was significant for the second, third and fourth stages, again indicating differential effects of competition upon the two ability levels. It was not significant for the first and last stages. These findings concur with the stated hypotheses. It was hypothesized that competition, initially, would have a detrimental effect upon all subjects. Further it was postulated that the effects of competition would cease to be detrimental and become facilitating early for high ability subjects but late for low ability subjects.

Initially, both the high and low ability groups were hindered by competition but within the first performance stage the HAC group surpassed the HANC group (Figure 7). A trend is evident from the performance curves, indicating that competition was having opposite effects on the performance of the high ability and low ability groups. This trend became more pronounced through the next three stages wherein the interaction effect of competition and ability level was significant. Through stages two, three and four the HAC group performed progressively better than the HANC group. This supports the view that competition would have a facilitating effect on the performance of high ability subjects early. On the other hand, through stages two and three the LAC group performed progressively worse than the LANC group. In stage four, although the interaction effect was still significant, the LAC

group began to overtake the LANC group (Figure 7). The LAC group had still not equalled the performance of the LANC group in stage five, but it had come much closer, so that the interaction of competition and ability level was no longer significant. This tends to support the hypothesis that competition would be beneficial to the performance of low ability subjects later in performance. The fact that the low ability performance curves did not reach an asymptotic level together with the shape of the curves gives rise to speculation, that if further trials had been given, the LAC group would have surpassed the performance of the LANC group.

Further support is given to the initial hypotheses about early and late effects of competition upon high and low ability subjects by examining the effects of competition upon the two ability groups separately. Competition had a significantly detrimental effect upon the performance of low ability subjects during the second stage. It had a significantly beneficial effect upon performance of the high ability subjects during the fourth stage.

One result, which was not consistent with the stated hypotheses, was the lack of a significant effect of competition upon the performance of the high ability group in stage five. This failure was due to an unexplained improvement in the performance of the HANC group during this stage.

The differential effect of competition upon performance at different performance stages is consistent with the results of studies

investigating the effects of various stressors upon performance (5,7,11,12,22,71).

Learning

In terms of overall learning (Table XIV), the competition and ability level main effects were significant. The low ability group (i.e., LAC plus LANC) improved significantly more than the high ability group (i.e., HAC plus HANC) and the competitive group (i.e., HAC plus LAC) improved significantly more than the non-competitive group (i.e., HANC plus LANC). The significant effect of ability level upon learning would be expected, as the initial scores of the low ability group were much poorer, and thus it would be easier for them to improve than for the high ability group. The fact that competition had a significant effect upon learning was less predictable. As was pointed out in the review of literature, numerous studies have found competition to facilitate learning and performance (1,10,14,20,43,61,63,65,67,83,91,95,96,97) while others have found it to have a detrimental effect (20,63,70,82,91,95) or to have no effect (26,27,66,87,91). There was no significant interaction effect of competition and ability level upon learning scores. Competition, therefore, had a similar effect upon learning within the high and low ability groups.

The overall learning was fractionated into early or first-half learning (Stage I minus Stage III) and late or last-half learning (Stage III minus Stage V). The only significant effect upon first-half learning was that due to ability level. The failure of the competitive

effect on learning to reach significance is expected as the early beneficial effect of competition on the high ability subjects would tend to cancel out the early detrimental effect of competition on the low ability subjects. Neither of the separate effects of competition upon the two isolated ability groups approached significance. In other words, competition did not significantly affect the amount of learning of either the high or low ability subjects.

In terms of last-half learning, competition had a significant beneficial effect upon the learning of the low ability group (Table XIII). This result is in accordance with the hypothesis concerning the beneficial effect of competition on low ability subjects late in learning. When the high and low ability groups were considered together, competition did not significantly affect the amount of late learning. Also, the ability level main effect on learning fell below the significance level, indicating that the high and low ability subjects did not significantly differ in terms of amount of late learning.

It is evident from Figure 7 and Table XIV that the LAC group learned more than the HAC group during the twenty-five trials. This result is in accordance with the results of earlier studies (44,63,95). Two possible explanations for this occurrence seem plausible. Firstly, the superior subjects were already performing at a higher level than the low ability subjects and thus it would be more difficult for them to improve their performance. Secondly, the high ability subjects might have been initially more highly motivated than the low ability

subjects and thus the additional motivation due to competition would have a smaller effect on their performance.

Competition had a significant effect upon the rate of learning as evidenced by the significant competition x stages interaction effect (Table XV). This result is in opposition to Ryan's findings for the effect of electric shock upon the rate of learning a stabilometer balancing task (73). This variance in results may be due to one of several differences between the two studies. Ryan used electric shock, college students, and twelve trials in his study while competition, junior high school students and twenty-five trials were utilized in the current study.

Results of this Study in Terms of Other Drive Theories

Although the hypotheses stated in this study were formulated on the basis of the Yerkes-Dodson Law and the results have been discussed in terms of this theory, other theories may also be applied. The activation theory advocated by Duffy (23) and her associates is applicable to the results. In terms of this theory, it can be argued that the initial decrement in the performance of the low ability group, under competitive circumstances, occurred because they were over activated. The low ability subjects might have been optimally motivated by the challenge of just performing the stabilometer balancing task. The introduction of competition would have raised their activation level above the optimum; thus the LAC group would perform more poorly than the LANC group. In the later stages of learning, as the subjects became

accustomed to the task, their activation levels would drop. This would account for the tendency, in the later trials, for the performance of the LAC group to approach nearer to that of the LANC group. The high ability subjects may have been under activated, thus the presence of competition would aid their performance by bringing their activation levels nearer to the optimum.

Spence's theory of competing responses (86) can also be used to interpret the results of the present study. Spence said that, if in the beginning stages of learning, the desired response is stronger than the incorrect ones, then the higher the drive level the better will be the performance and the fewer the errors. In terms of this theory, in the present study, it can be said that the correct response was stronger than the incorrect responses for the high ability subjects. Thus competition facilitated better performance of this group throughout the performance trials.

For the low ability subjects, however, the correct responses would not initially be the dominant ones; therefore competition would not initially facilitate performance. Instead, according to Spence's theory, competition would cause an increase in the percentage of errors during the initial stages of learning until sufficient practice had occurred to make the correct responses stronger than the competing incorrect ones. This would appear to have occurred during the fourth performance stage (Figure 7), wherein the performance curve for the LAC group approached nearer to that for the LANC group. The fact that the LAC group did not surpass the performance of the LANC group late in

performance does not contradict Spence's theory. As has been previously pointed out, insufficient trials were utilized to enable the low ability performance curves to reach an asymptote. The trend of the curves tends to indicate that, if more trials had been given, the LAC group would have surpassed the performance of the LANC group.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The purpose of this study was to investigate the effects of aspects of competition and varying ability levels upon the learning and performance of a motor task. Seventy-two grade eight male students were utilized as subjects in the study. They were given a five trial pre-test on the stabilometer in order to dichotomize them into high and low ability groups. The thirty-six high ability subjects were then randomly assigned to two groups as were the thirty-six low ability subjects. One of the high ability groups and one of the low ability groups were randomly selected to be the experimental (i.e., competitive) groups. The two remaining groups were assigned to be the control (i.e., non-competitive) groups. The control subjects were individually tested on twenty-five trials on the stabilometer task. The competitive subjects were paired on the basis of pre-test scores and then were tested on twenty-five trials under competitive conditions.

The twenty-five trial scores were sub-divided into five equal stages and two-way analyses of variance were calculated for each stage. In addition to the ability level and competitive main effects, the interaction of the two, and the separate effects of competition within the high and low ability groups were calculated for each stage. A trend

analysis of the total twenty-five trials was computed to determine the overall ability level, competitive, and stages main effects and the ability level x competition, ability level x stages, competition x stages, and ability level x competition x stages interactions.

Three learning scores (i.e., early, late, and total) were computed. Analyses of variance were performed on the three learning scores to determine what treatment effects were significant.

Conclusions

1. The high ability subjects performed significantly better than the low ability subjects during each of the five stages and in overall performance of the twenty-five trials.
2. Competition did not have a significant effect upon the performance of the combined high ability and low ability groups either in terms of overall performance or at the various stages.
3. Competition had a significant detrimental effect upon the performance of the low ability subjects during the second stage and a significant beneficial effect upon the high ability subjects' performance during the fourth stage.
4. Competition differentially affected the performance of the high and low ability subjects during the second, third, and fourth stages. It benefitted the performance of the high ability subjects and deterred that of the low ability subjects.

Conclusions 3 and 4 support the hypotheses that high ability subjects would benefit from competition early in the stages of learning while

competition would be detrimental to the performance of low ability subjects until late in learning. The hypotheses that a competitive situation would have an initial detrimental effect upon high ability subjects and that a competitive situation would have a beneficial effect upon the performance of low ability subjects late in learning were not statistically supported, although the performance curves did indicate a trend in the hypothesized directions.

5. The performance of the seventy-two subjects improved significantly over the five performance stages; thus, learning did occur.
6. The low ability subjects learned at a faster rate than the high ability subjects but they never equalled the performance of the high ability subjects.
7. The low ability subjects learned significantly more than the high ability subjects in the early (first-half) performance stages.
8. The LAC subjects learned significantly more than the LANC subjects during the late (last-half) performance stages. This conclusion further supports the hypothesis that competition would have a beneficial effect upon low ability subjects late in learning.
9. In overall learning, the low ability subjects learned more than the high ability subjects and the competitive subjects learned more than the non-competitive subjects.
10. Competition had a significant effect on the rate of learning. It retarded the rate of learning in the early stages and facilitated it in the late stages.

11. Competition affected the performance of the high and low ability groups, in the manner hypothesized, on the basis of the Yerkes-Dodson Law.

Recommendations

1. It would appear that the Yerkes-Dodson Law is a profitable line of inquiry for investigating the effects of competition upon performance. This was shown, in the present study, by the confirmation of the hypotheses, concerning the effects of stress (i.e., competition) on the performance of two different ability levels, at early and late stages of learning.
2. The present design would appear to be valuable for future studies concerning the effects of competition upon the performance of different ability levels. In subsequent studies, however, more learning trials should be administered to insure that the performance curves of the low ability groups, as well as those of the high ability groups, would reach an asymptotic state.
3. Studies should be performed to investigate the effects of competition and ability levels upon the performance and learning of discrete, serial and continuous tasks, in order to determine, if the effects are the same for each. Such studies should be extended to include different age groups and both male and female subjects.

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APPENDIX A PERFORMANCE SCORES

FIVE STAGE PERFORMANCE SCORES FOR THE HIGH ABILITY
- COMPETITIVE SUBJECTS (HAC)

<u>Subjects</u>	<u>Pre-test Score</u>	1	2	<u>Stages 3</u>	4	5
51	182	137.2	106.6	85.0	81.0	73.2
73	211	101.6	99.4	101.6	93.2	81.2
52	213	135.4	165.0	152.4	141.8	132.0
17	218	181.8	109.6	100.4	92.2	119.8
66	225	170.0	138.2	132.2	90.4	101.6
24	225	178.6	129.2	99.6	103.2	106.6
42	229	210.8	138.4	149.0	110.0	110.0
12	242	128.4	106.0	93.0	91.2	82.8
23	248	151.0	121.4	91.6	94.4	93.0
31	264	179.2	126.2	115.2	126.4	112.8
39	266	247.0	207.2	192.8	199.2	181.8
4	277	159.4	153.2	124.4	122.8	105.2
27	290	258.4	168.8	173.8	198.0	175.8
41	297	263.0	205.0	199.4	158.4	164.0
50	308	219.4	167.6	175.2	154.4	164.0
32	321	172.0	170.2	164.8	138.8	136.8
64	329	202.0	169.2	186.6	148.8	152.2
61	329	244.2	170.0	136.2	111.8	105.4

FIVE STAGE PERFORMANCE SCORES FOR THE HIGH ABILITY
- NON-COMPETITIVE SUBJECTS (HANC)

<u>Subjects</u>	<u>Pre-test Scores</u>	1	2	<u>Stages 3</u>	4	5
34	155	91.6	93.6	82.2	84.2	77.4
37	265	250.8	187.6	171.4	151.2	136.4
33	230	171.0	166.6	147.4	177.4	148.6
3	249	199.0	153.8	112.0	142.0	134.6
19	253	159.0	160.2	121.8	140.8	123.0
46	253	179.8	155.8	154.2	170.0	149.8
75	254	200.6	181.8	186.8	157.0	160.8
62	255	218.6	146.6	165.6	123.2	121.2
58	263	180.4	119.2	136.0	118.6	122.4
57	269	220.2	202.4	209.6	196.8	188.4
60	270	175.4	180.2	178.6	172.8	169.8
8	281	250.4	222.8	223.6	220.2	194.0
35	283	126.8	119.0	106.8	102.2	117.4
63	288	294.4	267.6	208.6	226.6	215.2
9	308	164.4	126.4	107.2	108.4	98.4
28	315	220.6	127.6	165.6	137.4	128.0
14	315	246.0	209.8	184.2	183.0	184.4
49	321	207.8	170.0	198.6	175.8	159.6

FIVE STAGE PERFORMANCE SCORES FOR THE LOW ABILITY
- COMPETITIVE SUBJECTS (LAC)

<u>Subjects</u>	<u>Pre-test Scores</u>	1	2	<u>Stages 3</u>	4	5
53	337	215.0	187.6	165.4	177.2	154.4
65	338	250.6	220.4	178.4	154.2	149.8
21	350	191.4	227.2	164.6	153.0	127.2
15	350	249.4	190.2	181.8	157.0	171.8
40	360	255.6	224.0	218.0	243.0	228.6
38	361	276.8	205.2	232.4	166.6	185.4
22	364	247.2	223.4	175.0	156.6	152.0
67	401	340.6	296.4	260.2	207.8	188.4
25	404	333.4	268.4	234.8	203.8	169.4
30	408	246.6	239.4	193.6	179.8	188.2
55	410	314.6	246.4	245.0	220.2	169.4
6	419	359.4	272.2	252.2	217.0	216.4
44	423	276.8	184.4	167.6	144.0	138.6
59	446	348.6	256.0	307.8	226.6	216.2
56	451	344.6	361.4	289.2	249.6	253.4
20	463	461.8	357.0	299.8	264.2	301.2
45	533	329.0	289.4	209.8	213.8	184.0
1	553	341.0	275.8	237.8	207.8	200.0

FIVE STAGE PERFORMANCE SCORES FOR THE LOW ABILITY

- NON-COMPETITIVE SUBJECTS (LANC)

<u>Subjects</u>	<u>Pre-test Scores</u>	1	2	<u>Stages 3</u>	4	5
74	343	226.6	182.6	177.8	193.2	186.4
47	350	213.6	171.4	121.6	162.8	168.2
69	350	237.0	220.8	215.4	204.6	227.8
26	357	215.8	176.0	155.2	125.4	110.8
16	370	156.2	120.0	131.8	125.4	171.2
68	372	251.0	157.4	165.6	193.0	152.6
43	382	237.8	221.0	189.6	142.0	145.2
2	391	275.0	165.8	177.8	144.4	174.8
18	392	250.6	234.4	219.4	199.4	207.2
11	399	323.8	231.4	234.4	245.2	174.6
29	403	263.0	220.0	196.8	152.8	125.0
54	407	316.4	235.2	204.0	225.8	207.6
7	427	362.8	321.0	269.8	244.8	229.8
13	435	162.2	175.0	147.8	124.6	123.8
5	436	332.8	262.6	234.4	222.6	213.2
77	403	287.0	212.6	199.8	180.4	147.2
10	530	294.6	259.4	228.8	237.6	208.0

Appendix B Learning Scores

Item	Item	Item	Item
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
24	24	24	24
25	25	25	25
26	26	26	26
27	27	27	27
28	28	28	28
29	29	29	29
30	30	30	30
31	31	31	31
32	32	32	32
33	33	33	33
34	34	34	34
35	35	35	35
36	36	36	36
37	37	37	37
38	38	38	38
39	39	39	39
40	40	40	40
41	41	41	41
42	42	42	42
43	43	43	43
44	44	44	44
45	45	45	45
46	46	46	46
47	47	47	47
48	48	48	48
49	49	49	49
50	50	50	50

LEARNING SCORES FOR THE HIGH ABILITY

- COMPETITIVE SUBJECTS (HAC)

<u>Subject</u>	<u>Early Learning</u>	<u>Late Learning</u>	<u>Total Learning</u>
51	52.2	11.8	64.0
73	00.0	20.4	20.4
52	- 17.0	20.4	3.4
17	81.4	-19.4	62.0
66	37.8	30.6	68.4
24	79.0	- 7.0	72.0
42	61.8	39.0	100.8
12	35.4	10.2	45.6
23	59.4	- 1.4	58.0
31	64.0	2.4	66.4
39	54.2	11.0	65.2
4	35.0	19.2	54.2
27	84.6	- 2.0	82.6
41	63.6	34.6	98.2
50	44.2	11.2	55.4
32	7.2	28.0	35.2
64	15.4	34.4	49.8
61	108.0	30.8	138.8

LEARNING SCORES FOR THE HIGH ABILITY

- NON-COMPETITIVE SUBJECTS (HANC)

<u>Subject</u>	<u>Early Learning</u>	<u>Late Learning</u>	<u>Total Learning</u>
34	9.4	4.8	14.2
37	79.4	35.0	114.4
33	23.6	- 1.2	22.4
3	87.0	-22.6	64.4
19	37.2	- 1.2	36.0
46	25.6	4.4	30.0
75	13.8	26.0	39.8
62	53.0	44.4	97.4
58	44.4	13.6	58.0
57	10.6	21.2	31.8
60	- 3.2	8.8	5.6
8	26.8	29.6	56.4
35	20.0	-10.6	9.4
63	85.8	- 6.6	79.2
9	57.2	8.8	66.0
28	55.0	37.6	92.6
14	61.8	- .2	61.6
49	9.2	39.0	48.2

LEARNING SCORES FOR THE LOW ABILITY

- COMPETITIVE SUBJECTS (LAC)

<u>Subjects</u>	<u>Early Learning</u>	<u>Late Learning</u>	<u>Total Learning</u>
53	49.6	11.0	60.6
65	72.2	28.6	100.8
21	26.8	37.4	64.2
15	67.6	10.0	77.6
40	37.6	-10.6	27.0
38	44.4	47.0	91.4
22	72.2	23.0	95.2
67	80.4	71.8	152.2
25	98.6	65.4	164.0
30	53.0	5.4	58.4
55	69.6	75.6	145.2
6	107.2	35.8	143.0
44	109.2	29.0	138.2
59	40.8	91.6	132.4
56	55.4	35.8	91.2
20	162.0	- 1.4	160.6
45	119.2	25.8	145.0
1	103.2	37.8	141.0

LEARNING SCORES FOR THE LOW ABILITY

- NON-COMPETITIVE SUBJECTS (LANC)

<u>Subject</u>	<u>Early Learning</u>	<u>Late Learning</u>	<u>Total Learning</u>
74	48.8	- 8.6	40.2
47	92.0	-46.6	45.4
69	21.6	-12.4	9.2
26	60.6	44.4	105.0
16	24.4	-39.4	-15.0
68	85.4	13.0	98.4
43	48.2	44.4	92.6
2	97.2	3.0	100.2
18	31.2	12.2	43.4
11	89.4	59.8	149.2
29	66.2	71.8	138.0
54	112.4	- 3.6	108.8
7	93.0	40.0	133.0
70	99.4	7.0	106.4
13	14.4	24.0	38.4
5	98.4	21.2	119.6
77	87.2	52.6	139.8
10	65.8	20.8	86.6

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